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THE NATION AND PETROLEUM GEOLOGY TO-DAY[1]

By HUGH D. MISER

U. S. GEOLOGICAL SURVEY

OUR nation is entrusted with a rich heritage of abundant petroleum. The annual output of this essential mineral fuel may be expressed in barrels and dollars, but to offer a fitting measure of its importance would require an appraisal of the service of petroleum in terms of human welfare and progress.

Chief among the many uses of petroleum is the generation of power. Such power drives 30 million motor vehicles on the nation's highways, 1½ million tractors on American farms, our merchant vessels and Navy on the ocean and our planes in the air. Altogether one third the mechanical energy produced in the United States comes from petroleum. Also, crude petroleum provides the plentiful supply of lubricants that has made possible our machine age.

The modern petroleum industry dates from the drilling of the Drake well in Pennsylvania in 1859 and, although the industry now encircles the earth, our country leads in the development of the industry and it produces and consumes three fifths of the world's oil. Also, our known oil reserves are equal to those of the rest of the world.

PRODUCTION OF PETROLEUM

The value of our petroleum output for 1938 expressed in dollars is one third the value of the entire annual mineral production of the United States. The next mineral product in point of value is coal, the next is natural gas, and then follows iron. Further

[1] Address of the vice-president and chairman of the section on Geology and Geography, American Association for the Advancement of Science, Columbus, Ohio, December 27, 1939. Published by permission of the director of the Geological Survey, United States Department of the Interior.

comparison reveals that the total value of all the metallic mineral products combined for that year is two thirds the value of the oil output.

Our domestic petroleum production is obtained from about 370,000 wells in 23 states; only a small part—about 5 per cent.—of our domestic consumption is imported from other countries, and the exports are equal in volume to 16 per cent. of the domestic production in 1938.

The production of petroleum in the United States has mounted rapidly during the twentieth century, when it has been related primarily to the expansion of the motor-fuel demand. The first billion barrels of oil had been produced by 1900, 41 years after the first barrel was recovered from the Drake well, but the present year, the eightieth anniversary of the industry, has witnessed the production of the 22-billionth barrel of oil. Of the producing states, Texas ranks first, having produced a quarter of the total output of the nation's oil to the end of 1938, California ranks second, with 24 per cent. of the output, and Oklahoma is third, being credited with 21 per cent.

Relation of Geology to Petroleum Industry

During the first half century of the petroleum industry geology was utilized only to a limited extent in the finding of oil. Progress was, however, being made from time to time in the demonstration of the relation of petroleum to anticlinal structure, and by 1915 this structural relationship had been established so clearly in numerous areas that geology was then generally accepted by the industry as a valuable tool in the search for oil.

The number of geologists now serving the industry in the United States, in the employ of companies and of governmental and other institutions, and in other capacities, appears to exceed 3,000—a number somewhat larger than the number of geologists in the United States who are members of the American Association of Petroleum Geologists. Altogether 2,638 geologists living in the United States were members of this organization on March 1, 1939; and of this number, 2,064 oil geologists live in the five leading oil-producing states, Texas, California, Oklahoma, Louisiana and Kansas. To express the quantitative relation of geologists to oil, there is one geologist for each half million barrels of oil produced in those states in 1938.

Current Methods Employed in Petroleum Geology

In the solution of the geologic problems involved in the search for oil new methods of technique and new trends in the application of geology are developed and adopted from time to time by the oil industry, and old methods and practices are frequently modified or abandoned. Some of the current methods and practices employed in petroleum geology are here briefly mentioned.

Surface geologic surveys to locate favorable areas for oil by the mapping of anticlines, domes and other structural features reached their peak application between 1920 and 1925 and have thus occupied for many years a place of decreasing importance in the finding of new oil fields. Accordingly, from year to year, an increasing proportion of effort and funds is devoted to the study of subsurface geologic features that are not discernible from an examination of the exposed formations.

Core drilling for the determination of geologic structure was first employed by the petroleum industry in the United States in 1919 and is still being employed in parts of the Mid-Continent region. Also, in this and other regions a current practice is to obtain the cores of oil sands and other important beds for a study of their character and fossil content. In recent years rapid routine methods for measuring the physical characteristics of sandstone cores have been developed. The laboratory orientation of well cores by their magnetic polarity, developed in 1928, provides a rapid and inexpensive method of determining the dip of core samples that have good bedding planes and a sufficient content of heavy minerals in which polarity has been induced by the earth's magnetic field.

The microscopic examination of well cuttings was begun on a large scale in 1917, and since that time it has reached a place of fundamental importance. A special method for the study of well cuttings of limestone and dolomites that was introduced in 1924 by H. S. McQueen consists of a microscopic examination of insoluble residues that are obtained by dissolving the cuttings in hydrochloric acid.

Micropaleontology has been an integral part of the oil business in the United States since 1924, and is employed for determining the age and local and distant correlations of the rock strata.

Geophysical methods, magnetic, gravimetric, electrical and seismic, are widely used in the United States as a means for locating and mapping buried structural features. In 1924 oil companies discovered three salt domes in the Gulf coast region by geophysical methods, and since then more than 100 salt domes in the Gulf coast region and numerous other structural features from New York to California have been located by such methods and later established by drilling.

The electrical logging of drill holes was developed in 1928, and its applications have become increasingly valuable from year to year. From the records of logs obtained by this method, the nature and thickness of all oil- and water-bearing zones are determined. Also their use permits short-distance correlation of formations within oil fields and, in conjunction with litho-

logic and paleontologic studies of cores and cuttings, permits also long-distance regional correlations.

A method, commonly known as "soil analysis," whereby the areas of greatest concentrations of hydrocarbons in the soils are determined, is at present receiving consideration as a possible aid in the exploration for oil.

A development that is of great value not only in geologic mapping but also in other phases of the oil industry is that of airplane photography. As a result of the tremendous improvement of airplanes, cameras and photographic methods during the last several years, mapping of this kind has become an indispensable tool of the petroleum industry. Indeed, aerial photographs are useful in so many industries and governmental activities that about two thirds of the area of the United States has been so photographed.

Contribution of Petroleum Geology to General Science of Geology

Petroleum geology enjoys a wide field of opportunity for the investigation of surface and subsurface geologic features. A great store of information has been provided by the 970,000 wells drilled for oil and gas in our country, and up to the beginning of 1939, 203 wells had been drilled below 10,000 feet. The deepest well, which was completed in 1938 in the southern San Joaquin Valley, California, reached a depth of 15,004 feet. In addition the depths reached by geophysical methods exceed 30,000 feet. From the information supplied by these and other sources petroleum geology has made notable contributions to the general science of geology.

One of these contributions has been the revolutionary change in our knowledge of the geology of the salt domes in Louisiana and Texas in the last quarter of a century. Now the domes are generally regarded as intrusive plugs of salt that moved upward from bedded salt of probable late Jurassic age. As an example of an area whose tectonic map has undergone great transformation as the result of oil exploration the Gulf coastal plain may be cited, for the tectonic map of that area has been modified by the addition of such structural trends as the Mexia fault zone, the buried course of the Ouachita belt of Paleozoic rocks and the Gulf coast geosyncline.

Stratigraphy, of a refined character, has received impetus in consequence of the requirements of the oil industry for exact information concerning the thickness and character of rock strata of prospective oil regions and of areas under development. For example, petroleum geologists, in their search for structural data in western Kansas, have matched the intervals between bentonite beds in the Niobrara chalk in a way suggestive of the matching of tree rings by archeologists in dating ancient pueblos in New Mexico and Arizona.

A scientific product of an investigation by N. W. Bass and his coworkers of the shoestring sand bodies that yield petroleum in Greenwood and Butler Counties, Kansas, and Osage County, Oklahoma, is that these elongated lenticular sand bodies represent sand bars along ancient shore lines during the Pennsylvanian epoch. From data obtained in the course of the investigation maps have been prepared showing the shore lines of the ancient seas as they existed in Kansas and Oklahoma 250 million years ago.

The deep drilling for oil and gas provides not alone stratigraphic information but also structural data that permit the preparation of subsurface structure maps, both local and regional in character. In the words of R. A. Daly at the banquet of the Geological Society of America in Tulsa, Okla., on December 30, 1931, the petroleum industry has contributed the third dimension to geology.

Discovery of Other Mineral Products

The petroleum industry, in its addition of this new dimension to geology, has had an unusual opportunity to discover new deposits of other mineral products. Commercially important deposits of five mineral products thus discovered with the advent of deep drilling and search for petroleum are natural gas, helium, natural carbon dioxide, potash in New Mexico and sulfur in the coastal areas of Louisiana and Texas. The five industries centering around these may thus be regarded as quintuplets of mother petroleum in the household of the mineral industry.

Reserves and Future Supply of Petroleum

The known reserves of petroleum in the United States at the beginning of 1939 reached the highest figure in the history of the industry. The different estimates of the reserves at that time ranged from 14 to 17.5 billion barrels. Such reserves in the ground, like the stocks of petroleum held above ground, are constantly changing in quantity. They are depleted by the output of producing wells and increased by the discovery of new fields and deeper pools.

The continued discovery of new sources of supply is essential for the survival of the petroleum industry. The extent to which new sources are discovered and made to produce depends upon the payment by the consumer of prices that will permit the industry to carry the heavy and increasing expense of new exploration and maintain profits.

Much oil remains to be discovered in new fields and in deeper pools, but the exact location of these fields and the quantity of petroleum they will yield will not be known in advance of drilling. Nevertheless, their number, whatever it may be, is definitely limited, and each newly found field leaves one less to be discovered. The day when the United States will

face a petroleum shortage does not now appear to be predictable. The distance to that day in the future lies not alone in the supply of oil remaining in the ground. It rests also with the geologist to continue to aid in the increasingly difficult problem of discovery, with the engineer to improve drilling technique and increase recoveries and with the chemist to continue improvements in refining practice. In part, it rests on the price that the public can pay in the future for oil products; the ability of the public to pay future prices in turn depends in part on increased efficiency in their use. In a large measure the distance to the day of petroleum shortage rests on conservation and efficiency in the discovery, development and production of our future oil fields.

Advances in science and technology affecting the discovery, recovery, refining and utilization of petroleum will undoubtedly continue. Thus far, such advances have enabled us to keep and augment supplies ahead of needs, but they afford us no assurance that the same record can be maintained indefinitely.

When a shortage of domestic crude petroleum arrives and there is a consequent rise in prices of petroleum products, substitute oil products from coal and oil shale, alcohol from farm products and gases from wood will be utilized, just as they are now used to some extent in certain countries that possess little or no oil resources. The cost of making gasoline from coal in British and German plants is probably three or four times the present cost of producing gasoline from petroleum in the United States. Concerning this subject Dr. Fieldner, of the Bureau of Mines, remarks: "These costs will be reduced by further research, but no other liquid motor fuel, whether it be from coal, oil shale, or vegetable matter, can hope to be as cheap as our present petroleum fuels." Should coal be called upon to supply the demands now met by oil and gas the coal deposits of the United States would, according to independent estimates by Dr. Fieldner and T. A. Hendricks, last about 2,000 years. These estimates are based on the assumptions that coal will be called upon to supply energy at the rate of the peak energy consumption of 1929 and also that there will be a 30 per cent. loss of coal in mining.

THE CASE AGAINST THE CELL THEORY[1]

By Professor BASILE J. LUYET

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MODERN biologists, in general, resent listening to theories; they are interested, they say, in facts only. But the organization of the present gathering and of many similar ones, all over the world, to commemorate the formulation of a *theory,* proves, on the other hand, that there is still some consideration for this form of intellectual activity. Why, then, do the biologists condemn theorization at times and honor it at other times? Is such an attitude mere inconsistency on their part? It seems, rather, that it is due to a state of mind which resulted from an apparent conflict between two evident facts: one is that theories have often been dangerous because they were held as doctrines; the other is that the elaboration of theories, at least in an implicit form, is a necessary and unavoidable procedure in any thinking. To reconcile ourselves with the situation we need only to recognize the necessity of theories but to remember also that they are dangerous tools which should be put in the hands of those only who know enough never to believe in them. The science of thinking consists in knowing how to use these tools, that is, in never admitting any theory except as a possibility. Since faith in theories has done much harm to human thought, the dangerous aspect of any theory, namely, to inspire belief, will be emphasized in the following discussion.

A theory is often considered acceptable if it is useful and if it allows one to foresee unknown facts. It is clear, however, that, in the last analysis, we require more than that from a theory; we want it to represent the truth. We are not satisfied in knowing what a thing might be, as proposed by any theory, we want to know what it actually is, and this is proposed by only one theory. When it becomes evident that a theory does not represent the truth, even if it has been useful and is still useful in the discovery of new facts, we abandon it and try a new theory which might have more chance of being the true one. In general, a theory is useful in proportion to its nearness to the truth, but there are examples of theories which have been useful for centuries and finally had to be abandoned as inadequate to explain newly discovered facts; such is the case of the old classical theory of the corpuscular nature of light. In the last analysis, then, the decision as to the acceptance or maintenance of a theory depends only on the answer to the question: Has this theory a chance of being true or not?

Let us come now to the definition of the cell theory. The statement of the fact that most living beings

[1] Address delivered to the Sigma Xi Club of Saint Louis University on April 18, 1939, at a meeting organized to commemorate the centenary of the formulation of the cell theory.

possess a cellular structure is often confused with the cell theory; and the discovery of the cell is assimilated to the formulation of the cell theory.

That most plants and animals are made of cells is a well-established fact based on innumerable observations, the first of which is generally attributed to Robert Hooke in 1665. As to the cell theory, it is only 173 years later, in 1838 and 1839, that it was clearly formulated by Schleiden and Schwann.

How does the theory differ from the fact? Essentially in this: the fact is that *most* living beings are cellular, and the theory is that *all* living matter should be cellular; in other words, the fact is that a cellular structure has been observed, and the theory is that such a cellular structure is a necessary condition for the existence of life.

In a condensed form, the cell theory can thus be formulated in the statement: "The cell is the fundamental structural and functional unit of any living matter." Schwann expressed it as follows: ". . . *all* organized bodies are composed . . . of cells" and ". . . there is one *universal* principle of development . . . the formation of cells."[2]

After these introductory definitions and remarks we come to the essential point of this discussion, which is the contention that the more we learn about life, the more the cell theory loses its chances of being true. The discovery, or the more complete observation of a number of facts during the 100 years which have elapsed since the formulation of the cell theory, as well as a more synthetic comprehension of these facts, make it now highly probable that the cell is not the necessary structural unit of any living matter. Like for many old theories, as those on the nature of light, on the nature of electricity, on the structure of matter, etc., the time seems to have come also for the cell theory to pass into the realm of the past. To abandon a theory which no longer agrees with newly studied facts is the only way by which matter-of-fact modern biologists can honor the pioneers who formulated it.

We shall discuss here briefly a few of the cases in which the inadequacy of the cell theory is more evident.

I. Coenocytes, Large Organisms not Divided into Cells

(1) *The Mycetozoa.* These animals (or plants) consist of large masses of living matter, sometimes as much as a pound, spread in a thin layer over an area of several square feet; the mass has usually an arborescent structure through the branches of which one observes an intensely active protoplasmic streaming. There is no trace of any division of the organism into cells (at least in the plasmodium stage). Yet all the vital functions—nutrition, respiration, secretion, locomotion and reproduction—are performed. A complete vital activity in an organism not divided into cells indicates that the cellular structure is certainly not necessary for the carrying on of the living processes.

Some consider the mycetozoa as monocellular organisms of giant size. Others assume that the structure of the mycetozoa is, in the last analysis, cellular, because of the presence of numerous nuclei, the membranes of the cells having been resorbed in the evolution of these organisms. But either of these views is suggested by the cell theory itself, and to judge the adequacy of the theory one must confront it with uninterpreted facts.

(2) *The Phycomycetes.* Almost the entire class of fungi to which the common moulds belong, the phycomycetes, consist of a mycelium, that is, of a system of tubes, sometimes several centimeters long and about one fourth of a millimeter thick in which the protoplasm circulates back and forth as in the mycetozoa and in which there is no cell division at all. Only the reproductive cells separate off by cell walls. Two classes of fungi, which have much similarity otherwise with the phycomycetes, the ascomycetes and basidiomycetes, possess a mycelium divided into cells by transversal walls. We have therefore here, among closely related forms, cellular and non-cellular organisms, both performing their vital functions apparently with the same efficiency. The cellular structure is not, therefore, necessary for life.

(3) *The Siphonales.* What has just been said of the Phycomycetes applies also to an order of green algae, the Siphonales. Let us mention *Udotea,* which has the shape of a leaf 2 to 3 cm across; *Bryopsis,* which presents a finely branched arborescent habit and measures as much as 5 cm in height, and *Caulerpa,* which consists of leaf-like organs some 10 cm long carried on a rhizome provided with rhizoids. All these plants consist of a protoplasmic mass not divided into cells. In a closely related order, the Siphonocladiales, there are a few septa which are sometimes considered as cell walls separating giant multinucleated cells. It is clear that these latter plants represent an intermediate stage between the completely coenocytic and the definitely cellular green algae. As far as the vital functions are concerned, it would be difficult to state if they are enhanced, impaired or unaffected by the cellular structure.

II. Intracellular Differentiation

(1) *The Ciliates.* The ciliates are puzzling creatures on account of the highly differentiated characters which they present, despite their monocellular nature. Let us consider *Diplodinium,*[3] a ciliate which is par-

[2] Quoted by Sharp, in "An Introduction to Cytology," p. 7. Van Nostrand, 1921.

[3] See description by R. G. Sharp, in *Univ. Cal. Pub. Zool.,* Vol. 13, 1914.

ticularly remarkable in this respect. This animal has a rudimentary digestive *system,* including an esophagus and a tubular rectum. It possesses a nervous *system* which is endowed with several of the morphological features observed in metazoa, in particular, with a brain and a circumesophagal ring. The excretory system (the contractile vacuoles) is also a remarkably elaborate one. The presence, in a monocellular, of tubular rectum, an organ which in metozoa is always made of cells, the existence of a circumesophagal ring developed according to the same plan as in metozoa, where the cells are the building units, and the formation of other systems which have their cell-made equivalent in pluricellulars, all this shows that such systems do not require cells as structural units. In the three preceding sections it was concluded that the vital functions are possible without cellular structure, here we find that the systems which perform these functions develop without the intervention of cells.[4]

III. The Structure of Bacteria and Bacterioids

Whether or not bacteria are cells is, at present, an unsolved question. This fundamental point being unsettled, it can evidently not be raised as an argument against the cell theory. It should be noticed, however, that it is from the field of bacteriology that the cell theory has been most often frowned at. In other words, the inadequacy of the theory is felt throughout, although no definite argument can be formulated against it.

IV. The Infracellulars

(1) *The Chloroplastids.* It is a well-established fact that the chloroplastids metabolize, that they grow and that they multiply. Consequently, it would seem logical to consider them as living units. In fact, they are, in many respects, comparable to bacterioids. The bacteria, it is true, can be cultivated on various media, while the chloroplastids live only in protoplasm; this difference has probably had an important influence on the fact that the chloroplastids, unlike the bacteria, were never classified as biological species. The possibility that they are necessary parasites or symbiotic living beings did not receive the consideration that it deserves. Besides the general acceptance of the cell theory itself contributed to establish the view that they are mere cell constituents and can not be biological species. Our contention here is that the cell theory does not do justice to the biological properties of such units.

[4] C. O. Whitman, in his paper on the "Inadequacy of the Cell-Theory of Development," (*J. Morph.*, 8: 651, 1893), mentions another example (quoted from Gruber) of similarity in cellular and in intracellular differentiation. The membranellae formed on the monocellular organism *Stentor* have their morphological and functional equivalents in *Cyclas,* where they are made of cells.

It might be of interest to notice, although this has no bearing on the present subject, the enormous quantity of living matter represented by the chloroplastids. If one could put them all together and compare this mass to that of the other forms of living matter, one would probably obtain the highest percentage of all. To have an idea of the rapidity of their growth and reproduction one has only to look at the grass and foliage-trees in the spring.

(2) *The Viruses.* Among the so-called viruses some have been identified as small bacteria; what has just been said of bacteria and bacterioids applies to them. The others are so much a puzzle that even their vital character is a subject of controversy. Since the nature of these latter is unknown, it can not be brought to testify against the cell theory. But, though formal testimony is lacking, circumstantial evidence is accumulating, mostly in the new findings on viruses. When it was reported, for example, that some viruses were obtained in the crystalline form, there was a movement of surprise among biologists and it was remarked that such a discovery, if confirmed, might require that we change our definitions of life and of a living being. It seems that the surprise is attributable mostly to the state of mind created by the cell theory and that abandoning the theory might suffice to remedy the trouble. It is clear that a body which has the dimension of a molecule or assumes the crystalline structure can not be a cell, but why should it be a cell?

V. The Nucleo-Cytoplasmic Constitution of the Cell

Since the cells of higher animals and plants consist almost always of cytoplasm and nucleus it was soon admitted that this structure is as universal as the existence of the cells. Though not essentially a part of the cell theory, this conception is often considered as such. Its influence on biological thought is intimately related with that of the cell theory. We shall mention here two sets of observations which speak against the theory of a necessary nucleo-cytoplasmic association for the performance of vital processes.

(1) *The enucleation of cells by the method of centrifugalization.* During the last century, numerous investigations which consisted in separating by some method of dissection (merotomy) the cytoplasm and the nucleus of a cell, resulted in the general conclusion that life is possible only when these two constituents are present in a certain state of organization. But during the last ten years, several of these experiments have been remade with a method which did not require the insertion of dissecting instruments into the cell, the method of centrifugalization. It has been possible by this method to separate the nucleus from the cytoplasm, to expel the nucleus[5] out

[5] E. B. Harvey, *Biol. Bull.*, 71: 101, 1936.

of the cell and to stratify the cytoplasmic and the nuclear contents.[6] The results were that the cells so mutilated or disturbed were capable of further growth, division and differentiation.

(2) *The cells without nuclei of the Cyanophyceae.* According to modern plant cytologists there is a large number of Cyanophyceae (blue-green algae) of which the cells are without nuclei. This conclusion, it is true, has been reached only after a long period of hesitation, but the reason of the hesitation is to be found in the influence of the cell theory. The adventures of some investigators who wanted to find a nucleus in the cells of these plants would be amusing, if they were not a bit tragical. The Cyanophyceae were, for many years, considered as consisting of anucleated cells. Then it was found that they possess chromatin. This could do for a nucleus except that it was not aggregated in one mass, as in ordinary nuclei. So the notion of "diffuse nuclei" was created and readily accepted. But, a real nucleus should divide by mitosis. Sure enough, mitotic figures, although strange ones, having but a vague resemblance to typical mitotic figures, were observed. Finally, it was shown[7] that the chromatin of the Cyanophyceae has nothing whatever to do with the cellular division and that it appears to be an accidental and insignificant part of the cell. So now, as 50 years ago, the more plausible conclusion is that the Cyanophyceae consist of cells without nuclei.

In the case just mentioned the significant fact concerning the cell theory is the existence of cells without nuclei. That some investigators have been victims of the theory should not be brought as a charge against it, since it is not its content which is responsible for the mischief but the mere fact that it is a theory and, therefore, as we said, a dangerous tool.

The history of the development of the cell theory and its present status can be summarized as follows. One hundred years ago, Schleiden, a botanist, and Schwann, a zoologist, were struck by the fact that most plants and animals are built on the same plan, that is, by the juxtaposition of cells.[8] This interesting similarity led these two pioneers to generalize the observed fact. So they formulated the cell theory. During the one hundred years which have since elapsed, a number of new observations have been made which are not in good agreement with the theory: in particular, the existence of the coenocytes, their biological features, the similarity of differentiation in acellulars, monocellulars and pluricellulars, and the biological properties of infracellular units. Consequently, the theory of Schleiden and Schwann appears to the modern unbiased observer as a rather daring and unjustified generalization.

The body of biological knowledge which grew and developed so enormously during this century finds itself now enclosed in a tight carapace which hinders its further development. But our contention is that the carapace has cracked and that, after an instar period of one hundred years, the molting time has come. We invite the biologists, on the occasion of this centenary, to band together for removing the carapace.

A new theory will necessarily replace the old one. We expect that, in the elaboration of this new theory, consideration will be given to the fundamental fact that in the higher animals, when the developing embryo has reached a certain size, it undergoes a division into metameres, superimposed to the division into cells, while the less differentiated and usually smaller organisms (as the hydra) do not divide into metameres but have ordinarily their body partitioned into cells, and the smallest and least differentiated forms (as the bacteria) do not present any known partition. According to a new theory based on these principles, the cell would then cease to be the "fundamental structural and functional unit" of any living matter and the cellular structure would become, in the last analysis, simply one of the various methods used by nature to partition a large mass of protoplasm.

OBITUARY

ROYAL NORTON CHAPMAN

ON December 2, 1939, died Royal Norton Chapman in Minneapolis, after a short illness, and thereby was removed from active service in the science of animal ecology, one of its most distinguished servants.

Royal Norton Chapman was born in Morristown, Minnesota, on September 17, 1889, and after preparatory work at Pillsbury Academy in Owatonna, he entered the University of Minnesota, taking the degree of B.A. in 1914 and M.A. in 1915. Following this he was Schuyler fellow in entomology at Cornell University, taking his doctorate there in 1917. His University of Minnesota appointments began as a scholar in animal biology, in 1912, and ended as dean of the graduate school and professor of ecology, beginning July 1, 1939. In the interim he was a Guggenheim Memorial Foundation fellow, and traveling professor of the International Education Board of the Rockefeller Foundation, 1926–1927, and for nine years, from 1930 to 1939, the director of the experiment

[6] H. W. Beams and R. L. King, SCIENCE, 84: 138, 1936.
[7] G. Poljansky and G. Petruschewsky, *Arch. Protistenk.*, 37: 11, 1929.
[8] *Cf.* the title of Schwann's mémoire.

station of the Pineapple Producers Cooperative Association at the University of Hawaii, Honolulu. He was a starred member of the American Association for the Advancement of Science and a member of the Society of Naturalists, the Entomological Society, the American Association of Economic Entomologists, the American Society of Zoologists, the Ecological Society of America, the British Ecological Society, the Hawaiian Entomological Society, the Hawaiian Academy of Science, the American Association of University Professors, Phi Kappa Phi, Sigma Xi, Gamma Alpha and Alpha Zeta. He is survived by his widow, Helen S. Chapman, and three children, Frances, Joyce and Kent.

Dr. Chapman's career had just entered its third phase when death overtook him. The first phase might be said to have begun in 1917 when he started his lecture course in animal ecology, and ended when he left the University of Minnesota to assume the directorship of the Pineapple Experiment Station in 1930. When the writer first met Chapman, it was in this lecture course, in 1923, and by that time it was evident that a new and fundamental approach was being developed, and a new "school" founded. Most of the students at that time were men of rather mature years, many of them with field experience behind them. On these men, Chapman's brilliant exposition of the field, his insistence on an objective, quantitative approach and his marshalling of what had previously been a wide array of scattered facts, left a permanent impression; and on their work, the unmistakable imprint of a master.

In the climate of Minnesota it was inevitable that attention would center on the environmental responses of laboratory animals and thus was begun the long series of studies by Dr. Chapman, and a devoted group of students of animal environments, on *Tribolium confusum* Duval. Whether Tribolium will be to ecologists what Drosophila is to geneticists remains to be seen; whether or not "biotic potential" and "environmental resistance" are but old concepts in new dress is not particularly important. What is important, is the indubitable fact that for the old natural history approach has been substituted a method comparable with that of the exact sciences, whereby the environmental responses of insects can be studied in an objective, quantitative manner. Both concept and method have since been widely used and will continue to influence students in that field for a long time to come.

The second phase of Chapman's career began in 1930 when he left Minnesota to become director of the Pineapple Experiment Station in Honolulu. From the standpoint of the continuation of *Tribolium* studies, this move was disastrous, but to the then newly expanded station devoted entirely to pineapple problems, Chapman brought a rich academic tradition and the bold initiative of a man fresh from recent successes. Then followed the golden age of the Pineapple Experiment Station and as a result the pineapple industry passed from a stage wherein biological problems in the field were the limiting factors to one wherein the problem is essentially that of disposing of a stabilized production. To the Graduate School of Tropical Agriculture, Chapman also brought to Hawaii a vision which some day, when the United States realizes more fully the enormous possibilities for research in tropical agriculture in the Islands, will bear fruit. But even though developments along these lines have been slow, they have been real, nevertheless.

It was during this nine-year stay in the Islands that Chapman's astonishing versatility made itself evident. As a local newspaper said on his leaving, "He has taken his place among men who give themselves and their energies and talents to the progress of Hawaii in cultural as well as in national affairs." He was in turn, president of the Institute of Pacific Relations, and the Y. M. C. A., both of which posts made large demands on his time. In addition to these, there was scarcely a single phase of public service to which he did not at one time or another make useful contributions. But although he revelled in the active and extremely varied life in the Islands, it was inevitable, to those who knew him, that when the opportunity came to return to his academic life, he would take it. For there was where his heart was. It was quite true that his life in the Islands had admirably prepared him for the public relations aspects of his new post as dean of the Graduate School in Minnesota but the everlasting conflict between the academic point of view and the requirements of a privately supported experiment station were extremely distasteful to him. He had, for nine years, privately financed and conducted his experiments on Tribolium populations, under many difficulties, and he left Hawaii in the summer of 1939 to return to his real field of research.

We in Hawaii were spared the intimate contact with the grief of his passing and the writer is glad that his last personal recollection of him is as he saw him in September of last year, full of enthusiasm for the graduate school and for the rehabilitation of his personal research program. Chapman's first appointment at Minnesota was as "scholar in animal biology." His last appointment, though called by a different name, meant just that.

WALTER CARTER

PINEAPPLE EXPERIMENT STATION,
UNIVERSITY OF HAWAII,
HONOLULU

RECENT DEATHS AND MEMORIALS

DR. DAVID MURRAY COWIE, professor of pediatrics and infectious diseases and chairman of the department of pediatrics of the Medical School of the University of Michigan, died on January 27 in his sixty-ninth year.

EMBERT H. SPRAGUE, professor of sanitary engineering and head of the department of engineering at the University of Maine, died on March 9 in his sixty-sixth year.

DR. LEON E. JENKS, of Sauquoit, N. Y., who was research chemist for the General Chemical Company in New York from 1927 until his retirement in 1935, died on March 8 at the age of sixty-three years.

DR. S. J. HICKSON, from 1894 until his retirement with the title emeritus in 1926 professor of zoology in the University of Manchester, died on February 6 at the age of eighty years.

FORMER students and friends of the late Dr. Henry Van Peters Wilson, who was Kenan professor of zoology at the University of North Carolina, are endeavoring to raise funds to establish a suitable memorial in the form of a summer scholarship for studies of marine biology at the seashore or a small library endowment. The chairman of the committee receiving funds is K. P. Battle, of Rocky Mount, North Carolina, and the treasurer, R. E. Coker, Chapel Hill, North Carolina.

SCIENTIFIC EVENTS

THE BRITISH ADVISORY COUNCIL ON SCIENTIFIC RESEARCH AND TECHNICAL DEVELOPMENT

AT the first meeting in London of the British Advisory Council on Scientific Research and Technical Development, Colonel J. J. Llewellin, who opened the meeting in the absence through illness of Mr. Burgin, the Minister of Supply, as reported in the London *Times*, said that the ministry already had an extensive Directorate of Scientific Research which served all three defence departments. The ministry had also been able to supplement the resources of the directorate with extensive assistance from research laboratories in universities and in industry.

The Advisory Council, of which Lord Cadman is chairman, is the senior advisory body of the ministry upon all matters of pure and applied science. He stated that "the ministry looked upon the council not only to help to make weapons superior to those of the enemy and to indicate efficient antidotes to any 'secret' war weapons we may have to meet but also to assist if possible in the development of new processes of rapid production. It was hoped, too, that the council might be able to assist in the appropriate utilization and conservation of raw materials and the discovery of substitutes for materials wherever that might be desirable."

According to the *Times*, Lord Cadman said that "the council had an extensive research program before it which included more than 1,000 items for investigation. The range of subjects was striking, covering on the one hand the most exacting chemical work in the explosives section to the most refined physical research in the communications section. Because of the variety of subjects to be dealt with it was essential to have a council membership of not less than twenty-five and to have many committees of the council on which outside scientists also would serve.

"With the impetus which it was hoped the council would give to military research they would, no doubt, have some proposals of a major character. It was expected that the committees would recommend changes in existing researches, both in nature and the financial provision needed for them.

"The Ministry of Supply, Directorate of Scientific Research, had a personnel of about 900, but even so there was plenty of ability outside the permanent staff capable of helping and willing to do so. The directorate was so constituted that advantage could be taken at any time of outside facilities and outside personnel could be engaged for investigatory work. Such services would be paid for."

THE PRACTICE OF MEDICINE AND THE SHERMAN ANTI-TRUST LAW[1]

THE United States Court of Appeals on March 4 reversed a district court decision by Justice Proctor that medicine was a "learned profession" and therefore not within the scope of the Sherman anti-trust act. As part of its decision, the Court of Appeals said, "The fact that defendants are physicians and medical organizations is of no significance." At the heart of the litigation is the question whether the law against restraint of trade applies to the medical profession. The court said, "We think enough has been said to demonstrate that the common law governing restraint of trade has not been confined, as defendants insist, to the field of commercial activity, ordinarily defined as 'trade,' but embraces as well the field of the medical profession." Again the court said, "It can not be admitted that the medical profession may through its great medical societies, either by rule or disciplinary proceedings, legally effectuate restraints as far reaching as those now charged." In addition the Court of Appeals held that, while the charge against the American Medical Association may be wholly unwarranted,

[1] From the *Journal* of the American Medical Association.

"For present purposes we must take the charge as though its verity were established; and, in that light, it seems to us clear that the offense is within the condemnation of the statute." The court also said, "It certainly can not be doubted that Congress intended to exert its full power in the public interest, to set free from unreasonable obstruction the exercise of those rights and privileges which are a part of our constitutional inheritance, and these include immunity from compulsory work at the will of another, the right to choose an occupation, the right to engage in any lawful calling for which one has the requisite capacity, skill, material or capital, and thereafter free enjoyment of the fruits of one's labors." And, it stated, "Congress undoubtedly legislated on the common-law principle that every person has individually, and that the public has collectively, a right to require the course of all legitimate occupations in the District of Columbia to be free from unreasonable obstruction, and likewise in recognition of the fact that all trades, businesses and professions which prevent idleness and exercise men in labor and employment for the benefit of themselves and their families and for the increase of their substance are desirable in the public good and any undue restraint upon them is wrong and is immediate and unreasonable and, therefore, within the purview of the Sherman act." Further, the court said, "We are mindful of a generally known fact that under these rules and standards [of the medical profession] there has developed an *esprit de corps* largely as a result of which the members of the profession contribute a considerable portion of their time to the relief of the unfortunate and the destitute. All of which may well be acknowledged to their credit. Notwithstanding these important considerations, it can not be admitted that the medical profession may, through its great medical societies, either by rule or disciplinary proceedings, legally effectuate restraints as far reaching as those now charged." Although the attorneys for the American Medical Association have not yet reached a decision as to the next step to be followed, it seems reasonable to believe that they will now go to the United States Supreme Court with a request for a definite decision as to whether or not the practice of medicine comes within the purview of the Sherman anti-trust law.

THE QUARTERLY JOURNAL OF STUDIES ON ALCOHOL

THE editors wish to announce the founding of a new scientific periodical to be called *The Quarterly Journal of Studies on Alcohol.* This journal has been accepted as the official organ for the Research Council on Problems of Alcohol, an associated society of the American Association for the Advancement of Science.

The Editorial Board as now constituted includes Dr. Emil Bogen, Dr. Karl M. Bowman, Dr. Anton J. Carlson, Dr. Thorne M. Carpenter, Dr. Harry R. DeSilva, Dr. Alexander O. Gettler, Dr. Leon A. Greenberg, Dr. Howard W. Haggard, *Editor,* Dr. Rolla N. Harger, Dr. Yandell Henderson, Dr. Norman Jolliffe, Dr. William deB. MacNider, Dr. Merrill Moore, Dr. Abraham Myerson, Dr. Winfred Overholser, Dr. Nathan Rakieten, *Managing Editor,* Mr. Eugene V. Rostow, *Medicolegal Editor,* Dr. Thorsten Sellin, Dr. Edward G. Strecker and Dr. Ray Lyman Wilbur.

The journal will include five departments: (1) original scientific papers reporting experimental, clinical and sociological investigations and reviews; (2) editorials; (3) abstracts of the current scientific literature on alcohol; (4) medicolegal cases concerning alcohol; and (5) reports of the activities of the Research Council on Problems of Alcohol. In the main the journal will be devoted to original papers.

The first issue will appear in May. Investigators are invited to submit manuscripts to the editor, 4 Hillhouse Avenue, New Haven, Conn.

THE CHEMIST ADVISORY COUNCIL

DEAN WILLIAM T. READ, of the School of Chemistry of Rutgers University, has been elected president of the Chemist Advisory Council, guidance service and clearing-house of information for chemists and chemical engineers with headquarters at 300 Madison Avenue, New York City. Dean Read succeeds Dr. Walter S. Landis, vice-president of the American Cyanamid Company, New York City.

Dr. Gustavus J. Esselen, president of Gustavus J. Esselen, Inc., Boston, has been named vice-president. M. R. Bhagwat, of New York, continues to be secretary and Dr. Robert T. Baldwin, of New York, treasurer. Members of the board were reelected as follows: Frederick M. Becket, of the Union Carbide and Carbon Research Laboratories, New York City; Professor Marston T. Bogert, of Columbia University; Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research, Pittsburgh; Maximilian Toch, president of Toch Brothers, New York City, and Frank G. Breyer, of Singmaster and Breyer, New York.

Over 1,300 chemists and chemical engineers residing in 45 states, including graduates of 192 educational institutions, have used the services of the council during the past two years. Its activities are supported by voluntary contributions, 75 per cent. of which have come from individuals employed or connected with the chemical profession.

Founded in 1938, the council is a permanent national organization to render immediate service to unemployed chemists and chemical engineers and to provide a broad and fundamental program of guidance

based on the long and varied experience of the various emergency organizations which preceded it.

The official statement points out that the council is doing a work that can not be done by either employment agencies or want advertisements. It is an advisory organization. Younger chemists are given an opportunity to learn about chemical industries. Chemists with experience are told more about industries outside their own immediate field. A number of university and industrial executives are giving liberally of their time to supplement the work of the secretary in advising registrants. All services are free.

THE HERZSTEIN LECTURES

THE Morris Herzstein Course of Medical Lectures for 1940 will be given by Dr. David Bruce Dill, of Harvard University, on April 8, 10 and 12.

The titles of the lectures will be:

April 8—"High Temperatures." Racial and individual adaptability to hot climates; various types of breakdown in temperature regulation; clinical applications of hyperthermia.

April 10—"Low Temperatures." Metabolic and dietary adjustments in cold climates; dependence of resistance on the internal environment; clinical applications of hypothermia.

April 12—"High Altitudes." Respiratory adaptations to oxygen lack.

These lectures will be given in the Auditorium of the University of California Extension Division at 540 Powell Street, San Francisco.

The Morris Herzstein Lectures were established in 1929 by the late Dr. Morris Herzstein, of San Francisco, to be given under the direction of the Medical Schools of Stanford University and the University of California. They are given on alternate years by scientific men of outstanding achievement and are open to the public as well as to the medical profession.

Previous courses of Herzstein Lectures have been given as follows:

1929. "Influence of the Sympathetic Nervous System on the Activity of Skeletal Muscles, of Sensory Receptors, and of the Central Nervous System," Dr. L. A. Orbeli, professor of physiology, Medical Institute of Leningrad.

1930. "Medieval and Modern Medicine," Dr. Charles Singer, lecturer in the history of medicine, University of London.

1932. "Carbohydrate Metabolism," Dr. Philip Anderson Shaffer, professor of biological chemistry, Washington University School of Medicine, St. Louis.

1934. "The Internal Secretions of the Anterior Lobe of the Pituitary Body," Dr. Herbert McLean Evans, professor of anatomy, Morris Herzstein professor of biology, director of the Institute of Experimental Biology, University of California at Berkeley.

1936. "Precept and Practice of Preventive Medicine," Dr. John Gerald FitzGerald, professor of hygiene and preventive medicine, director of Connaught Laboratories, School of Hygiene, University of Toronto.

1938. "The Problem of High Blood Pressure," Dr. George W. Pickering, lecturer in cardiovascular pathology, University College Hospital, London.

SUMMER MEETINGS OF ECOLOGISTS

THE 1940 summer meeting of the American Association for the Advancement of Science will be held at the University of Washington, Seattle, from June 17 to 22, inclusive. The Ecological Society of America will participate as an affiliated society.

These two organizations will present jointly the third of a series of summer meeting symposia. The Ecological Society is planning a few field excursions of interest to animal and plant ecologists. In addition it will hold two sessions for the presentation of papers, for animal ecology and plant ecology, with papers in bio-ecology assigned to either.

Members wishing to present papers should send in the title, the time for presentation (not over 20 minutes) and facilities desired (lantern, chart hangers, etc.) at as early a date as possible so that a satisfactory grouping of related papers can be effected. A member who can not be present at Seattle may arrange to have a paper read. Non-members may present papers when introduced by a member.

All material requested on papers may be mailed either to the secretary of the society, Dr. W. J. Hamilton, Jr., Cornell University, or to any of the three members of the executive committee of the Western Section of the Ecological Society of America, so that the material will be in the hands of the chairman of this committee by May 1. This is necessary in order to secure publication in the program of the Seattle meeting. Members of the executive committee are:

Dr. Frederick A. Davidson, Bureau of Fisheries, 2725 Montlake Boulevard, Seattle, Wash.

Professor Joseph Kittridge, Jr., University of California at Berkeley.

Dr. H. de Forest, *chairman*, University of Southern California, Los Angeles.

SCIENTIFIC NOTES AND NEWS

DR. KARL T. COMPTON was the guest of honor on March 5 at an alumni dinner in the Hotel Waldorf-Astoria, New York City, on the occasion of the tenth anniversary of his presidency of the Massachusetts Institute of Technology. The speakers were: Dr. Frank B. Jewett, president of the Bell Telephone

Laboratories and of the Alumni Association; Dr. Vannevar Bush, president of the Carnegie Institution of Washington, formerly dean of engineering at the Massachusetts Institute; A. T. Glassett, president of the Technology Club of New York, and Eric Hodgins, publisher of *Fortune*. A congratulatory message was received from Governor Saltonstall, of Massachusetts. On behalf of the New York Alumni and the Technology Club, Robert E. Wilson, president of the Pan-American Petroleum Company, presented a silver tray to Mrs. Compton.

THE Philadelphia Award, consisting of $10,000, a medal and a scroll, was presented on March 7 to Dr. Thomas S. Gates, president of the University of Pennsylvania. The award was established in 1921 by the late Edward W. Bok to be presented annually for "an act or service calculated to advance the best and largest interests of the community."

THE daily press reports that, with the acquiescence of the trustees, Dr. Niels Bohr, professor of physics at the University of Copenhagen, has offered the gold medal awarded to him by the Franklin Institute of Philadelphia to be disposed of for the benefit of the Finnish Relief Fund. In a cable to the vice-president of the fund Dr. Bohr said: "In Denmark the name of Franklin is a symbol of liberty."

DR. CARL J. CORI, professor of zoology at the University of Prague, observed his seventy-fifth birthday on February 24.

DR. HENRY E. SIGERIST, professor of the history of medicine and director of the Institute of the History of Medicine at the Johns Hopkins School of Medicine, who was South African visiting lecturer in 1939, has returned to the United States. During his visit he received an honorary degree from the University of Witwatersrand.

SIR HUMPHRY ROLLESTON, chairman of the executive committee of the Imperial Cancer Research Fund since 1924, has been admitted to honorary fellowship in the Royal College of Surgeons, London.

DR. ETIENNE BURNET, director of the Pasteur Institute of Tunis, has been made a Commander of the French Legion of Honor.

The British Medical Journal states that Professors Emil Abderhalden, of Halle; August Bier and Sauerbruch, of Berlin; Albert Döderlein, of Munich; Franz Volhard, of Frankfort; Hans von Haberer, of Cologne; Erwin Payr, of Leipzig, and Ludwig Aschoff, of Freiburg, have been made honorary members of the Vienna Medical Society.

DR. HORATIO B. WILLIAMS, Dalton professor of physiology at Columbia University, a member of the faculty since 1911, has been elected president of the Columbia Chapter of the Society of Sigma Xi, to succeed Professor Arthur W. Thomas, of the department of chemistry. Professor Selig Hecht, of the department of biophysics, has been elected vice-president.

OFFICERS of the Royal Astronomical Society, London, for 1940–41 are: *President,* Professor H. C. Plummer (reelected); *Vice-presidents,* Professor David Brunt, Professor Alfred Fowler, Dr. H. Spencer Jones (reelected) and Sir James Jeans; *Treasurer,* J. H. Reynolds (reelected); *Secretaries,* Dr. R. d'E. Atkinson and D. H. Sadler (reelected); *Foreign Secretary,* Sir Arthur Eddington (reelected).

THE U. S. National Committee of the International Electrotechnical Commission has elected E. C. Crittenden, chief of the Electrical Division of the National Bureau of Standards, as president to succeed Dr. C. H. Sharp, who has been named honorary president to succeed the late Dr. A. E. Kennelly. L. F. Adams, assistant to the vice-president of the General Electric Company, has been named vice-president, and H. S. Osborne, of the American Telephone and Telegraph Company, vice-president and treasurer.

THE Senate confirmed on March 9 the reappointment of Dr. Thomas Parran, of New York, as head of the U. S. Public Health Service for four more years.

DR. LOUISE STANLEY, chief of the Bureau of Home Economics, has been appointed by the U. S. Department of Agriculture as its representative on the council of the American Standards Association to succeed Dr. T. H. MacDonald. Dr. MacDonald is head of the Bureau of Public Roads, which has been transferred from the Department of Agriculture to the Federal Works Agency, a member body of the American Standards Association. Dr. MacDonald is now representing the agency on the council. Dr. D. J. Price, of the Bureau of Agricultural Chemistry and Engineering, will continue as representative of the U. S. Department of Agriculture.

DR. WLADYSLAW GORCZYNSKI, from 1919 to 1926 chief of the Polish Weather Bureau, who has been engaged recently in research at the Scripps Institution of Oceanography of the University of California at La Jolla, has been made research associate at the institution.

ARISTID V. GROSSE has resigned from his position as associate director of research for the Universal Oil Products Company. He is carrying on research at Columbia University.

DR. BYRON RIEGEL, instructor in chemistry at Northwestern University, has been given a grant of

$5,000 by the Rockefeller Foundation to aid his research in the chemistry of sterols. The money will be used to purchase equipment and to pay a laboratory assistant.

DR. GEORGE W. HUNTER, III, assistant professor of biology at Wesleyan University, has leave of absence for the second semester. He plans to work at the Biological Laboratories of Harvard University, where he has been appointed research fellow.

DR. GEORGE R. COWGILL, associate professor of physiological chemistry at Yale University, delivered the February Smith-Reed-Russell lecture at the School of Medicine of George Washington University. He spoke on "Nutrition and Public Health."

DR. DONALD H. MENZEL, professor of astrophysics at Harvard University, lectured on March 6 at a joint meeting of the Franklin Institute and the Rittenhouse Astronomical Association. His subject was "What is New in the Sun?"

DR. GEORGE E. VINCENT, formerly president of the University of Minnesota and later president of the Rockefeller Foundation, has been appointed the first James Humphrey Hoyt memorial lecturer at Yale University. The lecture will be given on April 3.

DR. RENÈ J. DUBOS, associate member of the Rockefeller Institute for Medical Research, will deliver the sixth Harvey Society Lecture of the current series at the New York Academy of Medicine on March 21. He will speak on the "Utilization of Selective Microbial Agents in the Study of Biological Problems."

PROFESSOR JEAN DUFRENOY, professor of plant physiology and pathology at the University of Bordeaux, lectured at the University of California on February 13 on "Oxidation-reduction Systems in Plant Cells," and on February 15 on "Phenolic Compounds in Relation to Plant Virus Diseases."

THE fifty-eighth course of Lane popular medical lectures will be given at the Stanford University School of Medicine on April 5 and 19 and May 3 and 17. The subjects and the lecturers are "Outstanding Achievements in Endocrinology," Dr. Hans Lisser; "Epilepsy and the Convulsive State," Dr. Frederick A. Fender; "Civilization's Challenge to Surgery," Dr. Nelson J. Howard; "Aviation Medicine," Dr. Eric Liljencrantz.

DR. CLARENCE A. MILLS, professor of experimental medicine at the University of Cincinnati, on February 20 and 21 gave addresses on climatic and weather effects before the Medical Association of the Isthmian Canal Zone and the Panama Canal Natural History Society. He was the guest of the Gorgas Memorial Laboratory, and while in Panama made plans for future studies in tropical physiology to be carried out there with the cooperation of various medical and health groups on the Isthmus.

THE meeting of the International Congress of Mathematicians that it was planned to hold at Harvard University in September has been cancelled.

THE committee of the British Physiological Society which was planning the seventeenth International Congress of Physiology at Oxford in August, 1941, under the presidency of Sir Charles Sherrington, has decided that the congress must be postponed. Arrangements for the future will be made in consultation with the Permanent International Committee.

THE tenth Congress of the Federation of Societies of Medical Science in North Africa will be held at Casablanca and Rabat, under the presidency of Dr. Dubois Roquebort, on March 22 and 23, when the subject for discussion will be diseases of the blood in North Africa.

THE eleventh annual meeting of the American Association of Physical Anthropologists will be held on May 2, 3 and 4 at the American Museum of Natural History.

THE sixteenth annual meeting of the American Heart Association will be held at the Hotel Roosevelt, New York City. The general cardiac program will be given on June 7, and the program of the Section for the Study of the Peripheral Circulation on June 8.

A COMPETITIVE civil service examination for the position of chief of the Bureau of Marine Fisheries of California's Division of Fish and Game, vacant through the recent retirement of N. B. Schofield, has been scheduled for April 13 by the California Personnel Board through its executive officer, Louis J. Kroeger. Residence requirements have been waived. The position pays at first a salary of $320 per month, and the requirements include education equal to that represented by graduation from college with specialization in biology, zoology or marine fisheries and more than five years' experience in fisheries research and major research projects, or an equivalent combination of education and similar experience. The work includes directing a staff engaged in a program of research for conservation and management of marine fisheries of the State of California, and coordinating the general work of the bureau with other divisions of the Fish and Game Commission. The exact date of the examination can be obtained by writing to the State Personnel Board, 1025 P Street, Sacramento.

THE Carnegie Corporation of New York has made a grant of $37,500 to the American Association of Museums. The grant is payable over three years for general expenses.

AT a meeting on March 2 the National Advisory Cancer Council recommended that grants be made as follows: The University of Chicago, $3,500 for the study of carcinogenic substances in human cancer and in the urine of cancer patients; The University of Michigan, $450 for study of the biologic action of cyclotron products; Meharry Medical College, Nashville, $1,100 toward maintenance of a follow-up system and records which may be available for statistical and other scientific studies, contingent on approval of the tumor clinic at the George W. Hubbard Hospital by the American College of Surgeons; The University of Cincinnati, $4,020 for study of the relationship of gastric cancer to chronic gastritis; Roscoe B. Jackson Memorial Laboratory, a grant, the exact amount to be determined, in aid of research on the genetics of cancer; The New York Hospital, $4,400 for continuation of studies on the early diagnosis of gastric cancer with special reference to the value of clinical methods.

A MAP which has been distributed to fellows of the American Geographical Society consists of a large sheet with eighteen colored maps giving much important information. In the preparation of the maps the research staff made use of more than a hundred and twenty-five different colored maps, many of them from rare central and eastern European publications, in the society's collection. A large map in the center of the sheet comprises all the more densely populated parts of Europe, showing towns, railroads, canals and international boundaries. Surrounding this are smaller maps illustrating types of land surface and land use, boundary changes since 1912, population, languages, international trade, mineral resources, navigable waterways, land and sea routes to the Far East, colonial possessions and certain facts about the climate of Europe of interest in connection with the war (such as ice conditions in the Baltic and White Seas). Although intended for general reference purposes and for use in following military movements, these maps also make clear many facts essential to an understanding of the European situation in its political, economic and strategic aspects. The maps are accompanied by a pamphlet containing explanatory text, a list of sources used, an index of some 2,300 names appearing on the maps and a special map of Finland and the neighboring regions.

AT the request of the directors of the American Chemical Society, according to *Industrial and Engineering Chemistry,* the chairman of the Patent Committee has reported that five of the seven patent law bills presented to Congress by the Monopoly Committee with the recommendation of Commissioner Cole have been passed by the House and Senate and signed by the President. These may be briefly summarized as follows: (1) Reduce from two years to one year the period within which an inventor may make public use of his invention before filing application for a patent. (2) Revise "interference practices" and reduce the number of hearings which may be held. Chairman O'Mahoney said applications for these hearings had been used for extending the life of patents. (3) Abolish so-called "renewal applications" for patents. (4) Extend the authority of the patent commissioner to enable him to require an applicant to respond to an official action within less than the current statutory period of six months. (5) Reduce the period within which to copy claims from an issued patent for the purpose of asserting priority.

DISCUSSION

CONIFER INFLORESCENCE AGAIN

SEVERAL essays of the past ten years, first appearing in SCIENCE[1] and then elsewhere at more length, assert the validity of the all-inflorescent view of the conifers. Meanwhile too, that long-delayed study of cone-development had been at last carried out by Hagerup, who, however, reaches a somewhat simplified floral view. He even suggests that through some course of reduction not a few of the angiosperms have been derived from older conifers not remote from *Juniperus.* Hence the century-long argument over the cone homology is yet on. No less, that more monomorphic view of an old, old history for all the lines of seed plants extending back to the Pteridosperms must be more than merely contentious.

Far too much significance has been given to the mere form of fossil evidence, with too little note of the arithmetic of occurrence. Moreover, many suggestions must yet come from the study of aberrant cones. Long since convinced that truer finality in the study of cycadeoid floral structures much depended on keeping the features of the conifers well in the foreground, I planted a series of my own. It was thought that by watching their growth through the years variations might be noted—ideas gained even over and above the texts. Such has proven to be the fact. The aberrant cone growths seem far more frequent than recorded in-

[1] *Cf.* Bibliography in Cerro Cuadrado Petrified Forest, *Carnegie Institution Pub. 449,* Washington, 1935.

stances imply. These two, as noted within the past year, are even remarkable:

(A) Excurrent growth of "seed cone" axis—*Sciadopitys verticillata* planted November, 1913, reached a height of about 35 feet, but had some seven feet of the summit broken off by the cyclonic storm of September 21, 1938. The first seed cones were sparingly noted in 1930. By the spring of 1938 various pollinial and seed cones appeared. In this latitude pollination is an early spring event. Later several of the seed cones were found with full-grown proliferate tines of the usual type. While this past spring and summer there appeared a fine seed cone terminating in four tines of the usual foliar type and well-grown as such. No anomaly has been noted in the pollinial cones, which are particularly handsome.

(B) Branched staminate conelets—*Cryptomeria japonica* planted 25 years ago was moved several times before taking on growth. The tree is now 20 feet high. As in the "umbrella pine" pollination occurs in the spring. Several years ago a single excurrently prolonged seed "cone" was seen, and last fall a few clearly branched conelets of the staminate groups were noted. This fall, however, with freer growth of cones, as almost entirely noted toward the base of the tree much better examples of the branched staminate conelets are present. They are finely grown at this writing (December 22); but the ovulate cones are few and not easy to find.

How interpret these recapitulatory growths? For the "umbrella pine," the seed cone axis may regain its original vegetative status, as lost in the leaf and "cone" evolution. The axis is in no sense a true floral axis, but is instead a vegetative branch bearing the bract-seed-scale complex which is floral and inflorescent.

In the *Cryptomeria,* on the contrary, an obverse condition becomes peculiarly instructive. The staminate groups are initially inflorescent in the same order and sense as the excurrent umbrella pine seed cone. The branched pollinial conelets thus become super-inflorescent. Whence they correspond to yet another anomaly especially well seen in the "Chinese black pine," where not infrequently seed cones are to be found intercalated amongst pollinial series.

These striking variations in floral growth require histologic study. That some of them may be brought about under experimental conditions is the near possibility. Finally too, the angiospermous flower appears very old and may have passed the point where the more clearly recessive anomalies appear. That the angiosperm inflorescence often remotely simulates the cones of conifers may be variously interpreted. But the better explanation is remote specialization. Any possible closer relationship between these lines would thus go back near to their defined point of origin in Paleozoic times.

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NATURAL OCCURRENCE OF TULAREMIA IN BEAVER AND ITS TRANSMISSION TO MAN

ON April 10, 1939, the State Game Warden of Wyoming telephoned that he had received a beaver from the northern part of the state which he wished examined to determine cause of death. A nail keg in which the specimen was shipped contained a skinned head wrapped in burlap and a gallon jar containing the viscera. The head was unwrapped, and some of the viscera were touched and turned over with bare hands. Upon discovering a general pyemia the hands were carefully washed in soap and water and rubber gloves used thereafter. Coccoid organisms were found in numerous whitish pin-head-sized or smaller pustules scattered throughout the mesenteries, liver and spleen. Noting an appearance similar to tularemia in ground squirrels, cultures were made from the spleen. The next day in the first transfer cultures, gram-negative rod-like organisms had developed from the coccoid forms, indicating a tentative diagnosis of tularemia.

On April 11, liver pulp was injected intraperitoneally into two young and two adult white rats. The two adult rats died April 14. One young rat died April 15, the other April 16. No lesions of any type were found at autopsy.

On the morning of April 16 the one who had handled the viscera felt dizzy and uncomfortable. This passed in half an hour, but recurred twice during the morning. There was a feeling of lassitude, as if some sort of toxin was in the system, coughed a few times during the morning and each time felt reaction at base of brain similar to severe cold or "flu." Was feeling well by evening. April 20 and 21, felt slightly indisposed. At about 3:30 A.M., April 22, patient awoke feeling very uneasy, a little feverish, but was able to sleep after two hours. Upon arising at 7:30 was light-headed, disinclined to any muscular exertion, eyes sensitive to bright lights. Feeling of uneasiness increased during morning; a noticeable fever by 11:00 A.M. At 1:30 P.M. temperature was 100.5°. Physician diagnosed the case as tularemia. Upon driving an auto, muscular control felt uncertain, and soreness experienced in one shoulder. Rested and felt better by evening. Slept well. April 23rd, a feeling of exhaustion noticeable, sensitive to cold, disinclined to exercise. Temperature sub-normal from 96.7° F. at 8:00 A.M. to 97.9° F. at 8:00 P.M. April 24 at noon temperature 98.5° F, but still slight soreness noted in shoulder muscles and in axillary lymph glands under right arm, and uncertainty of muscular control. Milder recurring attacks, usually at about six-day intervals, took place with diminishing intensity for a period of more than three months.

The case report of J. A., who skinned the beaver, is interesting. At request of Mr. E. he looked over the beaver situation early in the fall of 1938 on West Pass Creek, Sheridan County, Wyoming. Beaver had put in many caches for the winter and prospects looked good for trapping. He worked as a game warden the first three months of 1939. Went to Pass Creek on April 1, and noticed many untouched caches. Found 21 dead beaver both young and old in one and one-half miles of creek, and believed many more died which he did not find; most of them dead for two months. Dead beaver were also found on East Pass Creek, and from an Indian he learned that beaver had died on Lodge Grass Creek, six or eight years ago, from unknown cause. Heard also of dead beaver on Little Horn River and on Goose Creek. On May 20, the beaver trapper wrote: "Was sick in bed with a high fever immediately following the beaver trapping. Then for a long time felt logy and every move cost a great effort. Only now have I begun to feel natural. Had several boils at the time, and what made me think it was the same malady as the beaver was a gathering under the arm pit. But it receded. A number of these beaver had a pus sac in the same place."

At the writer's suggestion a blood sample was taken on July 12 by Dr. Herbert L. Harvey, of Casper, Wyoming, and forwarded to Dr. R. R. Parker, Director, Rocky Mountain Laboratory, Hamilton, Montana. Dr. Parker's report follows:

Antigen-Bacterium tularense	Serum dilutions						
	1:10	1:20	1:40	1:80	1:160	1:320	1:640	1:1280
B. Tul. ...		4	4	4	4	4	2	..

4+=75 to 100 per cent. agglutination.
2+=25 to 50 per cent. agglutination.
Comment: Blood sample from J. A. agglutinates *Bacterium tularense* at a titer of 1:640.

The source of infection is uncertain. However, the following facts are interesting. In response to an inquiry on May 31, 1939, J. A. wrote: "There is a scarcity of rabbits on Pass Creek and some of the natives said they found dead ones last summer. The only parasites on these beaver were fleas, a reddish-brown hard-shelled flea which apparently isn't bothered by submersion. They are an annoyance skinning beaver and are not particular what they feed on. The beaver, by their signs, came out of the creeks and had broad trails into the alfalfa meadows where they fed, and if the rabbits were diseased they could have contracted it there." In the fall of the year beaver move about a good deal and this movement might have aided in spreading the infection. It is also possible that the infection was water borne, as suggested by Hammersland and Joneschild.[1] The fact that practically no beaver escaped the infection indicates that water may have been partly responsible for the character of the outbreak.

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[1] *Jour. Am. Vet. Med. Asn.*, January, 1940.

SYSTEMATIC HISTOPLASMOSIS IN THE UNITED STATES

BETWEEN the years 1906 and 1908 Darling[1] in Panama reported at autopsy three cases of a systemic parasitic infection, the causative agent of which he called *Histoplasma capsulatum*. At first thought to be a tropical disease protozoan in nature and closely related to kala-azar, it has since been proved by de Monbreun[2] to be a fungus infection. Subsequently five[1a] cases have been reported from widely separated areas in the United States.

We have had the opportunity of studying a case of histoplasmosis occurring in a colored male adult who was admitted to St. Philip's Hospital in March, 1939. This is the second known case in which diagnosis was made before death. A detailed report of this case, including complete autopsy findings, will be published later.

Due to the fatal termination of the majority of these cases before diagnosis could be established, much concerning the manner of infection, diagnosis and treatment of the disease is still obscure. We believe that histoplasmosis is much more common than the number of published cases would lead one to believe. It is suggested that the findings of an anemia with leukopenia in a weakened, emaciated individual running a septic temperature should lead one to search the blood smears carefully for the parasite-laden monocytes. The enormous number of parasites seen in bone marrow preparations would indicate that sternal puncture studies are diagnostic.

Diagnosis may also be made by culture of the blood on dextrose or blood agar slants. Other media suitable for the cultivation of fungi would probably be satisfactory as the parasite grows readily. Intraperitoneal inoculation of the growth from blood agar slants into guinea pigs produces a typical infection. At autopsy the parasite can be found in abundance in the infected organs.

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SCIENTIFIC PUBLICATIONS NEEDED IN FRANCE

ALL who can imagine or may remember the isolatio

[1] S. T. Darling, *Arch. Int. Med.*, 2: 107, 1908.
[1a] Two additional cases in which diagnosis was made a autopsy have been since added to the literature.
[2] W. A. de Monbreun, *Amer. Jour. Trop. Med.*, 14: 12 1934.

and difficulties and the intellectual vacuity inherent in some aspects of military service will understand the value of an organization recently created here with the title of *Service de Documentation Scientifique*. It is prepared to receive scientific publications, to make abstracts and translations and distribute them to a list of readers now in war work and for the most part deprived of library facilities. It will assemble articles on given subjects, utilize microfilm techniques in distributing copies of articles in full and provide many of the other services of a lending library.

Although many scientific journals are of course being received, it seems worth while to point out that reprints are of considerable value also and would be welcomed if mailed to Professor Joliot, Service de Documentation Scientifique, 18, rue Pierre Curie, Paris. Authors of scientific articles being currently published can contribute most helpfully by sending reprints in duplicate.

At the present time the following fields receive special attention: Physics, Physical Chemistry, Chemistry, Physics in Technology and Chemical Engineering, Physiology, Pharmacodynamics, Epidemiology, Hygiene and Nutrition. There is no implied rejection of other fields in natural science, but the fields mentioned are of special interest.

The values of such an undertaking are self-evident, and the above information for those who deplore the effects of war upon fellow scientists in France and upon science will probably require no special pleading.

ALAN GREGG

THE ROCKEFELLER FOUNDATION,
EUROPEAN OFFICE,
PARIS

SCIENTIFIC BOOKS

CHEMISTRY

A History of Chemistry. By F. J. MOORE, Ph.D., late professor of organic chemistry in Massachusetts Institute of Technology. Revision prepared by William T. Hall, associate professor of analytical chemistry in the Massachusetts Institute of Technology. Third Edition. xxi + 447 pp. 94 illustrations. New York and London: McGraw-Hill Book Company, Inc. 1939. $3.00.

THE popularity of the late Professor Moore's "History of Chemistry," which was first published in 1918, is attested by the fact that it has now entered its third edition with an increase in size from 292 to 447 pages and in number of illustrations from 74 to 94. The continuation of the book through its second and third editions is due to the labors of Professor Hall, who has been assisted in the choice of new material and the reading of proof by his colleague of Massachusetts Tech., Professor Tenney Davis. The present work shows several important departures from the method of treatment pursued in previous editions. One of these innovations is the devotion of more space to the work of American chemists, for the reason stated in the preface that "in the German books on the history of chemistry, which have been either directly or indirectly the sources of much information in all books on the subject, the work of American chemists has been neglected. . . . More attention in this book is, therefore, paid to the story of American chemistry than is customary in short histories."

The purpose thus announced is commendable, provided the proposed sketch of American chemistry be made to fit into the general picture of world chemistry without impairing its perspective. This necessitates maintaining the same balance of treatment in describing domestic achievements as is followed in depicting foreign accomplishments. Unimportant developments are to be rejected, while major attainments must not be ignored. The violation of this principle of balance, which was so well maintained by Dr. Moore in the first edition of his book, is the reviewer's chief criticism of the new material introduced into the present volume. Fifteen lines, for example, are devoted to a sketch of Amos Eaton (an interesting but very insignificant figure in the history of world chemistry), while immediately afterwards only seven lines are devoted to Schönbein, a much more important chemical personage. The case for American chemistry could have been made much stronger if, instead of Eaton, readers were informed a little about J. W. Draper or Charles Goodyear, men of vastly greater chemical influence who find no mention in the pages of this new edition.

Histories of chemistry, as of other sciences, contain many inaccuracies that are simply copied without verification by one writer from another. The noted French chemist Dumas once wrote that Priestley died as a result of poison accidentally taken at a meal, and this erroneous statement with other inaccuracies has been copied and recopied so many times by French writers that the fiction, in France at least, has become almost an established article of belief. We Americans must not cast stones, however, for a goodly number of Priestley legends are being perpetuated right here at home. For example, on page 80 of the present volume it is said that after Priestley arrived in America, Benjamin Franklin tried to persuade him to live in Philadelphia. This statement is perhaps based on a remark of the late Dr. Lyman Newell (*Jour. Chem. Education,* 9: 682) that Franklin, who had been friendly to Priestley in England, "made strenuous

efforts to have the 'honest heretic' locate in Philadelphia instead of in Northumberland." The reviewer has been unable to determine who first gave rise to this pleasing phantasy. It is too bad to brand it as a figment of the imagination; Franklin died in 1790 and Priestley did not arrive in America until 1794.

Following the statement about Franklin, we note another oft-repeated legend that "Priestley discovered carbon monoxide after he came to America." This story has been reiterated so often by various writers that the reviewer, after a long belief in its truth, was finally led to ascertain the facts which, upon inspecting Lowry's excellent "Historical Introduction to Chemistry," were found to be as follows: Lassone first prepared carbon monoxide in France in 1776 by heating zinc oxide with charcoal and reported its property of burning with a blue flame; in 1777 Lavoisier independently prepared the same gas by heating charcoal with alum; in 1785 (nine years before he came to America) Priestley prepared the same gas by heating smithy scale and charcoal, noting, as did Lavoisier, that the inflammable air on combustion yielded fixed air (carbon dioxide), which led him to conclude that it was composed of fixed air and phlogiston; in 1801 Cruikshank, in England, proved the gas in question to be a new compound of carbon and oxygen, which he named gaseous oxide of carbon, but this view was criticized by Berthollet, who argued that the gas must contain hydrogen. Désormes and Clément, in France, proved, however, that no water was formed when the gas was burned, and hydrogen must therefore be absent; in 1849 Stas made the first accurate analysis of the gas, proving it to contain 57.16 per cent. oxygen and 42.84 per cent. carbon.

All this is a far cry from the statement that Priestley discovered carbon monoxide in America. Let us hope that these and other misleading legends about eminent chemists may cease to be published. The repetition of every kind of chemical hearsay is not the history of chemistry. The historians of our science should check quoted statements so far as possible with original sources of information. Students should be trained to cultivate this critical attitude in their history of science courses, and a more complete bibliography of reference works might have been given in the present volume to assist them in such collateral reading. The omission, for example, of a reference to the works of von Lippmann, the dean of historians of chemistry, is an unfortunate oversight.

The quotation on page 16 of the book that to one man science is a sacred goddess and to another only a cow who provides him with butter is not original with Liebig, as stated, but was taken by Liebig from Schiller's famous couplet entitled "Wissenschaft." The misspellings "Société d'Arceuil" (p. 122) and "Genthe" (pp. 335 and 438) are among other minor inaccuracies which should be corrected in a future edition.

The publishers must also do their part in helping to maintain the fine excellence of the first edition of Moore's "History of Chemistry." A comparison of the same illustrations in the first and third editions indicates a marked deterioration in some of the plates. The reinsertion of the list of plates, which is omitted in the present edition, would also be an added convenience.

C. A. BROWNE

BACTERIAL METABOLISM

Bacterial Metabolism. By MAJORY STEPHENSON, Sc.D. Second Edition. 391 pp. London, New York, Toronto: Longmans Green and Company. 1938.

SOMEWHAT chemical, perhaps, for the average bacteriologist, and rather bacteriological for many biochemists, the book illustrates well the position of the worker in this field. Welcomed to neither group by its prophets, yet impelled to be on speaking terms with the subject-matter and disciplines of both, he is blessed with an abundance of problems, theoretical and practical, whose solutions frequently become incorporated in the thought of one or the other of the basic sciences, and in any event supply comfort to the discoverer in his academic solitude.

Perhaps the picture is not quite so dreary, for if one may judge from the bibliography, which covers fifty pages, great numbers of investigators, at one time and another, have invaded this scientific no-man's-land. Many of these have clearly returned unharmed to their own lines. Others have remained as prisoners, perhaps not entirely unwilling, in the other camp. But a third group (and here the metaphor fails) have elected to continue as Miss Stephenson herself has done, in the somewhat nebulous, but none the less fruitful field of bacterial chemistry, or chemical bacteriology, and to make contributions of general and far-reaching importance.

The book includes chapters on "Respiration," "Polysaccharides," "Fermentation," "Decomposition of Proteins," "Nucleic Acid," "Nutrition and Growth," "Nitrogen Fixation," "Autotropic Bacteria," "Bacterial Photosynthesis" and "Enzyme Variation and Adaptation."

The excellence of the chapters on "Respiration" and "Fermentation" perhaps reflect their writer's interest in these particular phases of the subject. Among the past generation of bacteriologists were a few sometimes referred to not quite reverently as "sugar-fermentators." Their aim was to collect all possible kinds of bacteria, or strains of one variety, and all conceivable (or available) carbohydrates, subject each of the latter to the influence of every one of the former, construct

large chart presenting the results, and write a paper. Could some of these earlier workers but have foreseen the gold mine of facts underlying each appearance of acid in his culture tubes, the history of much scientific progress in the last twenty years might have been quite different. Even now, decomposition of glucose to alcohol and CO_2 by yeast appears to be the best understood of these fermentative processes, resembling in many ways the oxidation of sugar in the animal body and involving the recognition of both the nature and function of certain "vitamins." Before these chapters can be extended to describe the detailed mechanisms of all the various types of bacterial fermentation and respiration, other equally important substances will have to be sought and their actions clarified.

The chapter on "Enzyme Variation and Adaptation" also bears directly on this problem, as well as on other matters of very broad biological interest. The purposeful production of strains of bacteria showing abnormal sugar fermentation, the development of an enzyme specifically decomposing the polysaccharide of the Type III pneumococcus or of one which oxidizes thiocyanates of gas-waste liquors may seem to be unrelated phenomena. One may well inquire, however, what further practical applications will develop from this ability of unicellular organisms to produce specific enzymes in response to particular stimuli and how far an understanding of the principles underlying it will go toward explaining, for example, antibody formation in the animal body.

The chapter on "Nutrition and Growth" provides a further example of the recent advances which characterize the entire subject-matter of the book. It is stated in the preface that "this subject (bacterial growth) now attracts mathematicians and statisticians less than formerly, but has passed into the hands of biochemists interested in problems of nutrition." The new type of investigations began to bear fruit not more than five or six years ago, and a rich harvest of new facts is appearing annually. Miss Stephenson's chapter admirably summarizes the situation at the moment of publication. The discovery by the L'Woffs that the V factor for the growth of the Pfeiffer bacillus was identical with cozymase, and that of Knight that vitamin B was essential to the growth of the staphylococcus, attracted the immediate attention of investigators of animal nutrition to the possibility of using bacterial growth as a tool in their own field. The recognition that nicotinic acid was essential to the staphylococcus and the nearly simultaneous isolation of this material from liver extract in connection with studies on growth of the diphtheria bacillus were followed in a matter of weeks by the demonstration that the same substance cured black tongue in dogs and pellagra in man. With the continued extension of the subject-matter of this chapter will come many further contributions of the greatest importance to both biochemists and bacteriologists.

Other chapters merit equally favorable comment. Those dealing with nitrogen fixation and photosynthesis are particularly stimulating. In short, it is not too much to say that the biochemist or bacteriologist who reads this book will not fail to derive profit from the variety of facts now available in this borderline field, and to see many applications of possible new methods to his own particular problem.

The book is well printed and singularly free from typographical and editorial mistakes. Miss Stephenson recently told the reviewer that it was full of errors of omission and commission, but to the casual reader, at any rate, this would appear to be an over-statement. It is replete with excellent charts and tables, which illustrate many of the actual experiments of those workers who have contributed to the establishment of bacterial metabolism on a basis where it may now perhaps be considered to represent a science in its own right.

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SPECIAL ARTICLES

A KINESTHETICALLY CONTROLLED MAZE HABIT IN THE RAT

THE problem of the role of kinesthesis in the control of such serial responses as are present in the maze habit has been investigated for thirty-odd years without a clear-cut proof that kinesthesis can control maze behavior. Watson believed that kinesthesis was the only necessary type of stimulus control, but later investigators were prompt in indicating the functioning of other types of stimulation both from within and without the maze. Lashley and Ball,[1] who used a simple alternation maze that was not rotated and whose units were not interchanged, severed practically all tracts in the spinal cords of rats, some tracts in one rat and other tracts in other rats, and found that the ability to perform the maze habit survived the operation irrespective of the locus of injury. The authors concluded that "the maze habit can not be interpreted as a series of kinesthetic-motor reflexes but must be referred to some intraneural mechanism capable of producing an integrated sequence of movements in the absence of directive sensory cues" (p. 100). These results were extended by Ingebritsen[2] to show that rats could acquire the maze habit after extensive cord lesions.

[1] K. S. Lashley and J. Ball, *Jour. Comp. Psychol.*, 9: 71–106, 1929.

[2] O. C. Ingebritsen, *Jour. Comp. Psychol.*, 14: 279–294, 1932.

Although Lashley and Ball's conclusion can be shown to be untenable on the evidence submitted, numerous experiments exist which show that kinesthetic sensitivity is so crude that it alone could not guide the pathway followed by the rat, that it can be greatly altered and the maze habit still persist, and that it can be eliminated as a differential factor by means of the double alternation technique and yet maze habits can be acquired.[3]

The whole drift of the interpretation of maze learning has been characterized by a tendency to deny the role of kinesthesis either in the acquisition of the habit or in its execution after acquisition. The extent to which such views can be carried is indicated by Honzik,[4] who worked with a complicated maze pattern and who wrote as follows: "The conclusion that is forced upon us by the results with blind-deaf-anosmic rats is not that kinesthesis has no function in learning but that an act can not be learned by kinesthesis alone. . . . Thus among the various senses kinesthesis holds the unique position that by itself it is powerless but can, when operating with other senses, assume a share in the management of acts initially learned through them" (p. 56).

There are essentially but two methods by which one can attempt to set up a habit which would be controlled by kinesthesis. The first method involves surgical interference with the animal in an attempt to eliminate all sensory avenues other than the kinesthetic and then find the animal able to learn the maze. The difficulty with this method is the impossibility of completely eliminating non-kinesthetic avenues of stimulation. The second method is to plan the maze and the method of experimentation in such a manner that, with a minimum of surgical interference, only kinesthesis can operate to determine which turns the animal shall make. If then the maze habit is established, the conclusion can be drawn that it is kinesthetically controlled. It is this second method which has been followed in the present experiment where I have had the assistance of Miss Beatrice Hall, a graduate student at Brown University.

The maze utilized was a block type elevated maze containing 8 culs-de-sac as diagramed in Fig. 1. Each individual block was 30 inches long, $1\frac{3}{4}$ inches wide and 12 inches high, so arranged that each cul was 9 inches long. The maze stood on a platform, mounted on castors, and could be easily rotated about its center. The sequence of correct turns was *lrlrlrlr*.

Five blinded untrained male white rats 90 days old were first trained to run 90 inches on a straight elevated path to food, 3 trials daily for 8 days. They were then transferred to the maze and given one trial daily, retracing not prevented, under the following conditions which were first used in the Clark University Laboratory by Casper:[5] (1) Between trials the ma

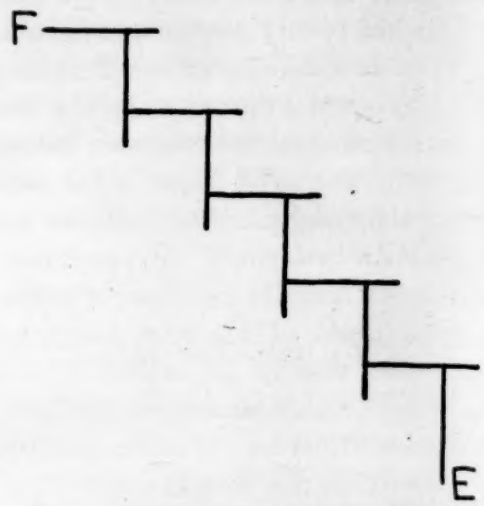

FIG. 1. The ground plan of the maze. E is the entrance; F is the exit where food was placed.

as a whole was rotated 45° clockwise, so that it never occupied the same position relative to stimuli from outside the platform for any two successive trials. Vision had been surgically excluded, and the changing orientation of the maze made it impossible for the rat to use extra-maze and extra-platform stimuli as directive cues for the correct responses. (2) Between trials all units of the maze were interchanged in one of 12 predetermined orders, leaving only the *lrlrlrlr* constant. Under these conditions no stimuli from the maze could afford differential cues controlling the direction which the rat should turn at the choice points.

All five rats learned the maze to a criterion of 10 perfect trials in succession in 9, 10, 9, 16 and 15 trials respectively, not counting the criterial trials. However, as early as the second trial one rat made but two errors, and brief sequences of simple alternation were common in all rats. The first completely perfect runs were made after 6, 4, 5, 3 and 2 trials by the respective rats.[6] The learning curves for time and errors per trial show no peculiarities, and hence they are not reproduced here. The distribution of the total errors of all rats per cul was as follows, taken in the order first cul to eighth cul: 36, 16, 6, 3, 2, 11, 7. It is thus clear that the greater difficulty lay at the two ends of the maze and the lesser difficulty in the middle culs. This was true for each rat, and it raises interesting questions about goal gradients. The last response learned by each rat was the correct (left) turn at the first choice point.

An explanation of this completed maze habit may be formulated in the following terms: When the rat

[3] W. S. Hunter, *Jour. Genet. Psychol.*, 36: 505–537, 1929. B. Casper, *Jour. Genet. Psychol.*, 43: 239–292, 1933.

[4] C. H. Honzik, *Comp. Psychol. Monog.*, 13: No. 4, 1936.

[5] B. Casper, *op. cit.*, p. 271 ff.

[6] W. Dennis and R. H. Henneman, *Jour. Genet. Psychol.* 40: 396–404, 1932, used normal (non-blinded) rats on a simple alternation maze of the present type and found that some rats made no errors on the first trial.

placed on the maze at the entrance, it is stimulated the maze and the experimenter. Call this total mulation S_E. S_E causes a response of running left the first cul. Call this response R_L. This turn to left and the approach to the next choice point pro- ce more stimulation from inside and outside the ze as well as kinesthetic stimuli within the rat. We ll call all these sensory consequences of R_L by the mbol S_L. S_L causes the rat to turn right (R_R) at next choice point; and R_R has S_R as its sensory nsequences. S_R is then followed by a left turn, etc., rough the maze. What the animal has had to learn, n, is to turn left for S_E and for S_R and to turn ht after being stimulated by S_L. We shall leave de the question whether the rat responds to S_L and as individual stimuli or as interrelated patterns, ce our major concern is with the sensory modality ich is controlling the behavior.

If the maze were not rotated and the units were not erchanged, there would be cutaneous and olfactory muli from the various maze units as well as kinesthe- stimuli from the animal's own activity which, with muli from outside the maze, would enter as com- nents of S_L and S_R as has been shown in the work Hunter, Honzik and Wolfle. If, however, as under present conditions, the maze is rotated and the ts are interchanged, S_L and S_R reduce solely to kinesthetic stimuli resulting from the rat's own ivity in making left and right turns, in so far as ferential stimuli are concerned. To be sure, the es of the paths stimulate the rat and "show" him en a turn is to be made, but such stimuli can not ermine the difference between a left and a right rn.

It is theoretically possible that some symbolic ocess, some symbolic equivalent of "go left-right- -etc.," may be present to control a habit set up der the above conditions, as indeed it would be were sequence of turns in double alternation *llrrllrr*.[7] wever, the presence of adequate differential kin- hetic stimulation makes such a hypothesis untenable the basis of parsimony; and the great difficulty ich the rat has with double alternation temporal oblems as compared with the great ease with which present maze habit was established renders the othesis of symbolic control still less tenable in the sent case.

The significance of the present experiment lies not y in its demonstration of a habit built up and con- lled by kinesthesis but also in the basis which is w laid for an extension of the neurological study such intelligent acts. A repetition of Lashley and ll's experiment on rats trained as here described t in alley mazes because of the rat's motor inco- ordinations) should show an interference with the habit if kinesthetic impulses are carried in definite tracts of the cord and if they can not shift to other tracts when their own are destroyed. Furthermore, cortical extirpations of the kinesthetic projection areas should reveal a localization of function in some rats as opposed to the equipotentiality which Lashley's work on the neural control of maze habits has hitherto supported. The expression "in some rats" is used advisedly because some rats can, with difficulty, develop the equivalent of symbolic controls. It remains to be determined whether or not localized brain lesions destroy the rat's capacity to perform the responses so controlled. (Jacobsen's[8] work indicates that monkeys are unable to relearn the delayed reaction, which is also symbolically controlled, after bilateral frontal lobectomy.)

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A RADIOACTIVE ISOTOPE STUDY OF THE ABSORPTION OF PHOSPHORUS AND SODIUM BY CORN SEEDLINGS

THE artificial radioactive method is readily adapted to studies of the factors influencing the absorption of mineral matter by plants. The design of Geiger counter developed in this laboratory[1] is suited to studies of this type, since it has a low background of only two counts per minute, since it will detect rays with energies as soft as 50,000 volts and since it yields quantitative results when calibrated against known solutions.

The technique involved in a quantitative study of the absorption of phosphorus and sodium by corn seedlings is simple. The plants tested were germinated in sand and the seedlings transferred to water or culture solution; at the time of the experiment they were about 12 inches high. In making the tests a measured quantity of radioactive phosphorus in the form of tripotassium phosphate or of radioactive sodium as sodium chloride was added to the culture solution. At regular intervals thereafter the plant was placed so that the leaf to be examined was directly below the counter window and the number of counts per minute were recorded.

Effects of various factors influencing the assimilation of phosphorus and sodium are illustrated in Figs. 1, 2 and 3. Fig. 1 shows the total number of disintegrations counted per minute per unit area of leaf as a function of time for different total phosphorus concentrations in the solution. Total phosphorus (radioactive and non-radioactive) taken up

[7] W. S. Hunter, *Jour. Genet. Psychol.*, 36: 512, 1929.

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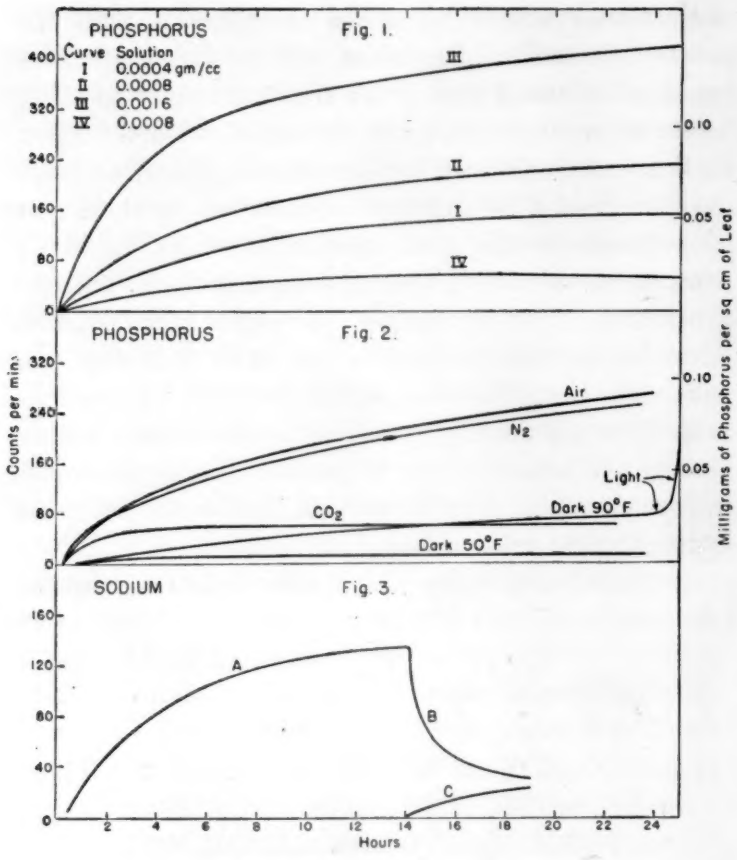

FIGS. 1–3

by the leaf and expressed in milligrams per sq. cm is computed directly from the number of counts per minute. The second leaf from the bottom, 2 inches from the base and 6 inches from the solution, was taken for study. Five minutes after radioactive phosphorus was added it could be detected in the leaves. Curves I, II and III show that for the concentrations tested the uptake increases with the amount supplied. Curve IV shows less uptake than Curve II, because in this case the plant was allowed to stand for 24 hours in a standard nutrient solution containing 0.0008 g of phosphorus per cc prior to the addition of radioactive phosphorus. Curve A in Fig. 3 is a corresponding uptake curve for sodium.

The distribution of phosphorus in the plant changes appreciably with time. During the initial stages of the experiment the number of disintegrations was from 25 to 50 per cent. more intense for the bottom than for the top leaf; it also decreased rapidly from the base to the tip of the individual leaves. The final distribution, in general, was quite uniform between the leaves as well as along each leaf except at the tip, which remained low.

Effect of the extent of root system on uptake was investigated in detail. For both sodium and phosphorus the rate and equilibrium value were found to be the same for intact roots, for plants with roots excised at different positions and for leaves removed at the base. Plants stunted in their early growth by a deficiency in their diet took up very little sodium or phosphorus due to an impairment which began in the root system and gradually extended up the stalk; in all stunted plants tested normal uptake was observed when the impaired section was removed.

Effect of surrounding conditions on the uptake of phosphorus is shown in Fig. 2. In each instance the plant was kept in the condition designated for 15 hours before adding radioactive phosphorus. Unfortunately it was necessary to expose the plants to room conditions for about three minutes every hour while the observations were being made. Absorption was very low while plants were in the dark but increased rapidly upon exposure to light. Low temperatures and an atmosphere of carbon dioxide decreased the uptake.

Elimination of phosphorus and sodium from the plant presents a different picture. Curve B, Fig. 3, shows decrease of sodium in the leaf when the plant (root system intact) was transferred from a solution containing radioactive sodium to one containing sodium. Curve C shows the increase of sodium in the solution due to back diffusion from the plant. Analogous results have been obtained by Jenny, Overstreet and Ayers[2] on the depletion of sodium from barley plants. The phosphorus content of the leaf, in contrast, decreased only slightly with time, while the radioactivity of the solution increased slowly through loss of phosphorus from the roots and lower portion of the stalk.

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A METHOD OF STUDYING THE AVAILABILITY OF VARIOUS SUBSTRATES FOR HUMAN BRAIN METABOLISM DURING THERAPEUTIC INSULIN SHOCK[1]

PERFUSION of whole organs,[2] arterial and venous blood sampling from intact organs in the body[3] and studies of surviving excised tissues in the manometric apparatus[4] have been the chief methods by which the metabolism of various organs, particularly the brain, have thus far been studied. The method of blood sampling has been successfully applied to the study

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[1] From the Division of Psychiatry, Bellevue Hospital, and the Department of Psychiatry, New York University Medical College, New York, N. Y.

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of human brain metabolism by means of the technique of puncture of the internal jugular vein described by Myerson, Halloran and Hirsch.[5] It has been amply demonstrated by all these methods that glucose is the main metabolic substrate for brain oxidations. In the absence of this substrate, during hypoglycemic insulin shock, it has been shown that the metabolism of the brain is diminished. This is indicated by an extremely low oxygen uptake of the brain,[6,7] in association with characteristic changes of the cortical brain potentials[8] and the onset of clinical coma. Earlier animal experiments[9,10,11,12,13,14] by numerous workers on the effect of various substrates on hypoglycemic symptoms probably have a significant bearing on brain metabolism, but the latter has not heretofore been studied directly under these conditions.

We have undertaken to study the relative availability of various substrates for brain metabolism by administering these substances intravenously during therapeutic insulin shock. We observed the effect of the various substrates on the clinical state of the patient. Simultaneously, the oxygen, glucose and lactic acid uptake of the brain was estimated from analyses of the arterial and internal jugular blood samples for these constituents. With the qualification that the observations were made on subjects suffering from schizophrenia, our data thus far reveal that glucose is readily available to the human brain as a source of energy, that lactic acid is not metabolized to any significant degree and that pyruvic acid and alcohol are not metabolized at all. It may be remarked that except for glucose these findings are in contrast to those reported on surviving brain tissue in the Warburg apparatus.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

EGGSHELL CAP METHOD OF INCUBATING CHICK EMBRYOS

AT the demonstration section of the American Society of Zoologists during the Columbus meetings of the American Association for the Advancement of Science, the authors presented a demonstration of chick embryos visible through openings in their shells, which during incubation were kept covered by eggshell caps. Embryos of 3, 6 and 9 days incubation were displayed. It will be a matter of interest to those who saw this demonstration that one of the embryos displayed subsequently hatched, as a normal chick, on January 11, after 21 days of incubation.

Similar hatching of chicks with this method in at least six different trials during the past year in this laboratory demonstrates the normalcy of development.

Various methods have been used (Kuo,[1] Orr and Windle,[2] Paff,[3] *et altera*) to observe and manipulate living chick embryos over a period of a few days, *in ovo*. However, none of the authors above reports attempts to carry embryos through to hatching. Paff recently used eggshell caps, but he reports their use only on 2-day incubated eggs as a means of introducing colchicine and incubating such embryos 24 hours or less. The present authors have tried the above-mentioned and several other methods. Normal development, complete incubation and successful hatching have resulted for them only when the eggshell cap method was used.

This method involves the removal of the eggshell and both eggshell membranes, to expose the embryo and its extra-embryonic membranes directly beneath. The embryo may thus be observed directly and is subject to manual manipulation.

The method of preparation is simple: First, an eggshell cap is prepared by breaking an egg at the small end, emptying the contents and, with scissors, cutting the empty shell around its middle. The result is approximately a half eggshell with a cross-section similar to Fig. A. It is then dried and both shell membranes are removed, as in Fig. B. The eggshell cap taken from the large end of the egg consists then of the shell only. It is sterilized with alcohol, dried, and kept in a covered container until used.

Eggs to be incubated are opened prior to incubation. Holding the egg vertically, with the large end uppermost near a bright lamp, a light area marks

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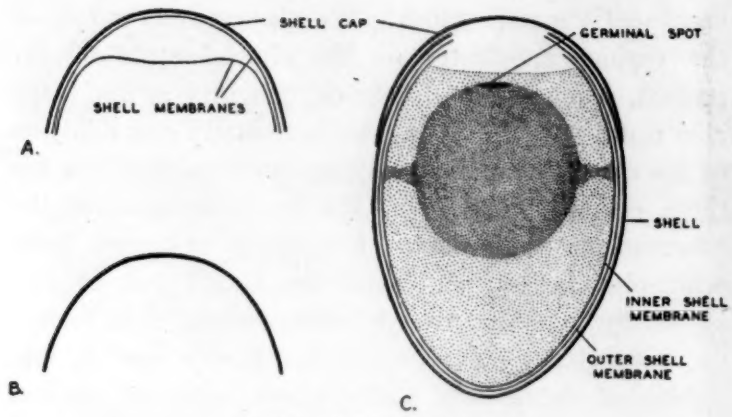

FIGS. A, B and C

the limits of the air cell in that region. After cleaning the eggshell with cotton moistened with alcohol, the outline of the air cell is marked with pencil. With tweezers a small opening is made above the air cell, and by careful chipping, pieces of shell and membrane are removed to make a circular opening somewhat smaller in diameter than the air cell beneath. With sterile tweezers the inner shell membrane is next removed to the same extent, leaving the albumen exposed. (See Fig. C.) The previously prepared shell cap is now placed over the opening and the egg is ready for incubation. The shell cap is not sealed in any way.

After several days of incubation the level of albumen within has dropped and permits the further removal of shell. Care must be taken to avoid injuring the allantois. With a relatively large opening, later stages of development are clearly visible over the entire upper surface.

In the incubator such eggs must be held vertically. Holes may be made in strips of coarse screening to hold the eggs in a standard incubator tray. If the egg is permitted to roll over on its side, albumen will be lost. Held vertically, apparently no turning of the egg is necessary. Difficulty of hatching may be avoided by sprinkling the 18-day egg with water.

The incidence of infection of embryos has been extremely low, considering the fact that the shell cap is simply laid over the eggshell opening and may be removed daily for observation of the embryo. The overlapping margin of the eggshell and its cap is apparently an effective barrier to bacteria. The porous shell of the cap apparently permits adequate gaseous exchange between the living embryo and the exterior, yet prevents excessive desiccation.

The simplicity of technique involved and the low mortality of embryos recommend this method for use in classroom demonstrations and as a source of normal living embryos readily accessible to the research worker.

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A SUPPLEMENTARY METHOD FOR THE STUDY OF ARACHNO-PIA

EXAMINATION of the leptomeninges in embedded and stained sections of brain and cord, at best, gives only a limited idea, even when made in series, of the relations and complexity of the varied and delicate parts of these membranes.

It is possible, by floating fragments of fresh or formalin-fixed tissue from water onto a glass slide, adding a drop of glycerine to the surface of the specimen and covering the whole in the usual way, with light pressure on the cover glass, to secure a preparation which can be examined with the dark field.

This gives a more or less stereoscopic picture of all the elements which are present in the tissue, as they appear free from the distortions of routine technic. When suitably prepared, very complete detail is visible. The vascular arrangement is made especially evident, and both intravascular conditions and perivascular spaces and tissues are clearly defined.

The method is of particular value for the study of meningeal concretions as well as of perivascular reactions. When combined with the routine staining technic, which brings out the detail of individual cell structures, this simple method furnishes a valuable supplement, and affords a completeness of examination which can be secured in no other way.

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